What is claimed is:

1. A micro-electro-mechanical system ("MEMS") optical switch comprising:

a base portion of a die attached to

a pivoting member with

a hinge, the pivoting member rotating in relation to the base portion about an axis essentially perpendicular to a major surface of the die;

a mirror having a mirror surface essentially parallel to the major surface of the die, the mirror being integrated with the pivoting member; and

an actuator disposed to rotate the pivoting member to move the mirror from a first switch position to a second switch position.

2. The optical switch of claim 1 further comprising a latching spring connected to the base portion and to the pivoting member.

3. The optical switch of claim 2 wherein the latching spring is a radial spring having a first arc of motion and the pivoting member has a second arc of motion, a the first switch position corresponding to a first intersection of the first arc of motion and the second arc of motion and the second switch position corresponding to a second intersection of the first arc of motion and the second arc of motion.

4. The optical switch of claim 3 wherein the hinge is connected to the base portion with a hinge post and the axis is offset from the hinge post.

5. The optical switch of claim 1 wherein at least a portion of the mirror in the first switch position extends beyond an edge of the die.

6. The optical switch of claim 1 wherein the portion of the mirror extending beyond the edge of the die extends at least about 400 microns.

7. The optical switch of claim 1 wherein the actuator is a magnetic drive.

8. The optical switch of claim 7 wherein the magnetic drive comprises

a first pole disposed on the base portion;

a second pole disposed on the base portion; and

a magnetic tab disposed on the pivoting member and movable within a gap formed between the first pole and the second pole.

9. The optical switch of claim 8 wherein the first pole, the second pole, and the magnetic tab comprise an alloy consisting essentially of 45% nickel and 55% iron.

10. The optical switch of claim 8 further comprising

a first sensing pole disposed on the base portion and

a second sensing pole disposed on the base portion.

11. The optical switch of claim 10 further comprising

a first core segment disposed on the base portion;

a first pinched region disposed between and magnetically coupling the first core segment and the first sensing pole;

a second core segment disposed on the base portion; and

a second pinched region disposed between and magnetically coupling the first core segment and the first sensing pole.

12. The optical switch of claim 1 wherein the hinge and the mirror are formed from single-crystal silicon.

13. The optical switch of claim 12 wherein the hinge and the mirror are formed in a layer of single-crystal silicon about 10-80 microns thick.

14. The optical switch of claim 12 wherein the mirror comprises a metallic film formed on the layer of single-crystal silicon.

15. The optical switch of claim 12 wherein the mirror comprises a thin section and a rib section, the rib section being thicker than the thin section.

16. The optical switch of claim 15 wherein the rib section has a first thickness and the thin section has a second thickness, the first thickness being about twice the second thickness.

17. The optical switch of claim 16 wherein the first thickness is about 40 microns and the second thickness is about 20 microns.

18. The optical switch of claim 16 further comprising a plurality of ribs disposed on a backside of the mirror.

19. The optical switch of claim 1 wherein the mirror has a first mirrored surface and a second mirrored surface.

20. The optical switch of claim 1 wherein the mirror surface defines an oval of about 1.4 x 1.0 mm.

21. The optical switch of claim 1 wherein the mirror surface defines an oval of about 780 x 550 microns.

22. A micro-electro-mechanical system ("MEMS") optical switch comprising:

a base portion of a die attached to

a pivoting member formed in a layer of single-crystal silicon with

a hinge formed of the layer of single-crystal silicon, the pivoting member rotating in relation to the base portion about an axis essentially perpendicular to a major surface of the die;

a mirror formed from the layer of single-crystal silicon and a metallic coating having a mirror surface essentially parallel to the major surface of the die, the mirror being integrated with the pivoting member; and

an actuator configured to rotate the pivoting member and mirror with respect to the base portion in response to a control signal.

23. A micro-electro-mechanical system ("MEMS") optical switch comprising:

a base portion of a die attached to

a pivoting member formed in a layer of single-crystal silicon with

a hinge formed of the layer of single-crystal silicon, the pivoting member rotating in relation to the base portion about an axis essentially perpendicular to a major surface of the die;

a mirror formed from the layer of single-crystal silicon and a reflective coating having a mirror surface essentially parallel to the major surface of the die, the mirror being integrated with the pivoting member;

a latching spring disposed between the base portion and the pivoting member to hold the pivoting member in one of a first position and a second position; and

a magnetic drive including a first pole and a second pole disposed on the base portion, the first pole and the second pole forming a gap therebetween in at least the single-crystal silicon layer and further including a magnetic tab disposed on an arm movable within the gap.

24. A method of operating a micro-electrical-mechanical system optical switch, the method comprising:

providing the optical switch in a first position;

providing a first pulse of current to a magnetic drive on the optical switch to rotate a hinged optical element about an axis essentially perpendicular to a major plane of the optical switch to latch the optical switch in a second position;

providing a second pulse of current to the magnetic drive on the optical switch to rotate the hinged optical element about the axis to latch the optical switch in the first position.

25. The method of claim 24 wherein the magnetic drive includes a first pole and a second pole forming a gap therebetween and a movable magnetic tab, the first pulse of current having a duration sufficient to accelerate the movable magnetic tab toward a center of the gap, and then to decelerate the movable magnetic tab from the center of the gap.

26. The method of claim 24 wherein the first pulse has a polarity and the second pulse has the same polarity.

27. The method of claim 24 wherein the first pulse has a maximum voltage less than 10 volts.

28. The method of claim 24 wherein the first pulse has a maximum voltage of about 5 volts.

29. The method of claim 24 wherein the first pulse has a maximum voltage of less than 5 volts.

30. The method of claim 24 wherein the first pulse has energy of less than about 2000 x 10^{-6} Joules and the optical switch switches from the first position to the second position in less than 50 mS.

31. The method of claim 30 wherein the first pulse has energy of less than about 300 x 10^{-6} Joules and the optical switch switches from the first position to the second position in less than 5 mS.

32. The method of claim 24 wherein the first pulse has a maximum voltage of less than 10 V and the optical switch switches from the first position to the second position in about 1 mS.

33. The method of claim 30 wherein the optical switch switches from the first position to the second position in less than about 300 micro-seconds.

34. The method of claim 24 further comprising steps of, after the step of providing the first pulse,

measuring an impedance of the magnetic drive; and

comparing the impedance against a reference value.

35. A method of operating a micro-electrical-mechanical system optical switch, the method comprising:

providing the optical switch in a first position;

providing a first pulse of current to a magnetic drive on the optical switch to accelerate a pivoting member toward a second position and then to decelerate the pivoting member to rotate a hinged optical element about an axis essentially perpendicular to a major plane of the optical switch to latch the optical switch in the second position;

providing a second pulse of current to the magnetic drive on the optical switch to accelerate the pivoting member toward the first position and then to decelerate the pivoting member to rotate the hinged optical element about the axis to latch the optical switch in the first position.

36. The method of claim 35 wherein the first pulse has a polarity and the second pulse has the polarity.

37. A method of fabricating a micro-electro-mechanical system ("MEMS") optical switch, the method comprising:

providing a process wafer having

a substrate,

an oxide layer; and

a superstrate, the oxide layer being disposed between the substrate and the superstrate;

removing a selected portion of the substrate to expose the oxide layer;

forming a selected pattern in the superstrate; and

removing a portion of the oxide layer underlying the removed selected portion of the substrate.

38. The method of claim 37 wherein the superstrate is single-crystal silicon between about 10-80 microns thick.

39. The method of claim 37 wherein the selected pattern in the superstrate includes a mirror structure and at least a portion of the removed selected portion of the substrate is opposite the mirror structure.

40. The method of claim 39 wherein the removing the selected portion of the substrate results in a plurality of vias through the substrate and the removing the oxide layer step includes removing oxide exposed by the vias and between vias.

41. The method of claim 40 wherein the plurality of vias is disposed in a selected pattern.

42. The method of claim 41 wherein the selected pattern comprises a rib pattern and the removing a selected portion of the substrate further includes removing a field portion of the substrate opposite the mirror structure, the method further comprising a step of

etching a backside of the mirror structure to thin a portion of the mirror structure underlying the removed field portion of the substate.

43. The method of claim 39 further comprising steps of:

smoothing a frontside of the mirror structure; and

forming a reflector on the frontside of the mirror structure.

44. The method of claim 43 wherein the forming step comprises depositing a layer of metal on the mirror structure.

45. The method of claim 43 wherein the smoothing step includes steps of:

forming a thermal oxide on the frontside of the mirror structure and

removing the thermal oxide.

46. The method of claim 39 wherein the removing the selected portion of the substrate opposite the mirror structure removes a field portion of the substrate wherein a backside of the mirror structure is exposed after the removing the portion of the oxide layer step, and further comprising steps of:

smoothing a frontside and the backside of the mirror structure;

forming a reflector on the frontside of the mirror structure; and

forming a reflector on the backside of the mirror structure.

47. A method of fabricating a micro-electro-mechanical system ("MEMS") optical switch, the method comprising:

providing a process wafer having

a substrate,

an oxide layer; and

a superstrate, the oxide layer being disposed between the substrate and the superstrate;

removing a selected portion of the substrate to form vias through the substrate exposing the oxide layer underlying the vias;

forming a selected pattern in the superstrate; and

removing a portion of the oxide layer underlying the vias and between vias.

48. A method of fabricating a low-inertia micro-electro-mechanical system ("MEMS") optical switch, the method comprising:

providing a process wafer having

a substrate,

an oxide layer; and

a superstrate, the oxide layer being disposed between the substrate and the superstrate;

removing a selected portion of the substrate to expose the oxide layer;

forming a selected pattern including a mirror structure in the superstrate, the mirror structure having a frontside and a backside;

removing a portion of the oxide layer underlying the removed selected portion of the substrate; and

removing a portion of the backside of the mirror structure.

49. The method of claim 48 wherein the removing a portion of the backside of the mirror structure includes removing the portion in a selected pattern.

50. The method of claim 49 wherein the selected pattern includes a first thinned section, a second thinned section, and a rib section disposed between the first thinned section and the second thinned section.

51. The method of claim 50 wherein the rib section is about twice as thick as the first thinned section.